Summer 2013

Research Newsletter

Responsive - Accessible - Relevant

A MESSAGE FROM THE RESEARCH DIRECTOR

By: Cameron Kergaye, PhD, PMP, PE

The Research Division is pleased to announce the selection of 28 new problem statements for FY14 funding. This represents a combined effort from experts within UDOT and our research community, and covers important subject areas including the recently introduced Transportation Innovation. Problem statements may be found on the Research Division website with a summary of selected problem statements included on page two of this newsletter.

Other good research news for UDOT is the selection of NCHRP research that supports the needs or interests of our state. There were a total of 68 NCHRP problem statements approved for FY14 funding by the AASHTO Board of Directors. UDOT ranked 23 of these problem statements as highly useful to our state, which represents over $10 million of valuable research. Though not specifically focused on Utah's transportation network, these soon-to-be-advertised research projects help improve our state system through applied study findings.

While the NCHRP research selection process concludes for FY14, preparations for next year are just beginning. The deadline for submitting problem statements to NCHRP for next year's consideration is September 16th. NCHRP problem statements may only be submitted by state or federal transportation agencies. However, transportation engineers at UDOT have partnered with our university and consultant experts in the past to co-develop and submit problem statements.

2013 Research Workshop Breakout Group

Lastly, I'm pleased to relate that two UDOT nominations were selected by the AASHTO Technology Implementation Group (TIG) as Lead States Team Focus Technologies for 2013. Each year the AASHTO TIG seeks advancements in transportation technology or related innovations that have been adopted by at least one agency. This year they selected two nominations from UDOT: UPLAN II and Traffic Signal Automated Performance Measures. Congratulations to those involved as they assist AASHTO in accelerating the adoption of these technologies to other agencies nationwide.

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Completed and Active Research Available at: www.udot.utah.gov/go/research

Editorial Staff: Steve Bagley sbagley@utah.gov and David Stevens davidstevens@utah.gov

By: Steve Bagley, M.P.C.
UDOT Research Division

Results of The 2013 Research Workshop (UTRAC)

Projects have been selected for FY14 funding from the 2013 UDOT Research Workshop held on April 8th.

Fifty-nine problem statements were submitted this year to the UDOT Research Workshop. Of these, twenty-eight will be funded as new research projects through the Research Division. Several projects of those submitted will be funded directly by other divisions.

The workshop serves as one step in the research project selection process which involves UDOT, FHWA, universities, private sector firms and other transportation agencies. UDOT Research Division solicited problem statements for seven focus areas: Materials and Pavements, Maintenance, Traffic Management and Safety, Geotechnical, Preconstruction, Planning and Asset Management, and Transportation Innovation .

At the workshop, transportation professionals met to prioritize problem statements in order to select the ones most suitable to become research projects. Two voting criteria were used: importance and implementation. All UDOT staff voted during the prioritization process.

After the workshop, UDOT Research Division staff reviewed prioritization and funding for each recommended problem statement with division and group leaders and presented the list of new projects to the UTRAC Council.

A few of the selected new projects include:

- Cold-In-Place Recycling (CIR) Phase IV - Performance Mix Design
- Implementation of Aerial/Mobile Lidar Technology to Update Highway Feature Inventory
- Calibration of Automatic Performance Measures Speed and Volume Data
- Evaluation of Finite Difference Approach to Estimating Consolidation Settlement
- Tacit Knowledge Management
- Asset Management 5-year Plan
- Precast Concrete Pavements for Urban Intersection Reconstruction

Also at the April 8th workshop, Marv Halling of Utah State University was presented with the Trailblazer Award for his significant contributions towards transportation research, specifically dealing with bridge structures.

Cameron Kergaye with Marv Halling of USU, Recipient of Trailblazer Award

A significant factor for success in the research selection process was the broad support from various UDOT Divisions and university representatives. We were excited that a number of projects may receive funding from other sources. Many UDOT divisions including Maintenance, Planning, Asset Management, Traffic and Safety and the TOC are considering contributing funding along with University Transportation Centers.

To see details on the list of final projects, visit the UDOT Research Division website . For more information contact Steve Bagley, at sbagley@utah.gov.

By: Russ Scovil, P.E.,
UDOT Research Division
Otakuye Conroy-Ben, Ph.D.,
University of Utah
Travis Christensen,
University of Utah

Reducing Highway Litter Along The Wasatch Front

UDOT Senior Leaders have recognized a problem with an increase in litter on State highways along the Wasatch Front and are looking for ways to reduce this problem. A research study was recently completed by the University of Utah to assist UDOT.

The type of litter that is found along Utah's highways varies greatly based upon location. Some types of litter that are common along Utah's highways are: cans and bottles, cigarette butts, fast food packing and wrappers, paper, construction material, and human waste. Roadside litter is not limited to the items previously mentioned; items such as a boat without a trailer, a complete engine and transmission, and a load of toilets have been found.

The main sources of roadside litter along Utah's highways are drivers who improperly secure loads, smokers, fast food patrons, commercial vehicle operators, and unsecured trash loads from commercial and private haulers enroute to a landfill.

The location of the road typically has the greatest effect on the amount of roadside litter present. The location of litter depends on many factors, including, nearby businesses, load type, and recreation type.

Data analyzed from 2008 – 2012 on litter and debris related crashes on Utah's highways (Figure 1), showed that there were between 650 and 800 litter related accidents during this time period. In 2008, there were 3 litter-related traffic fatalities, none in 2009, one in 2010, none in 2011, and one in 2012.

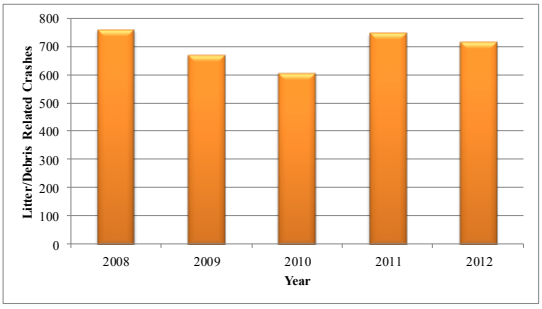


Figure 1 Litter & Debris Related Crashes in Utah

The cost of litter to UDOT for the period 2005 – 2012 ranged from $1.5 to $1.8 million (Figure 2). Total costs include litter control/contractual litter pick-up, spot litter control/animal carcass removal, and Adopt-A-Highway. Most costs are attributed to litter control and contractual removal, but these costs have been decreasing since 2005.

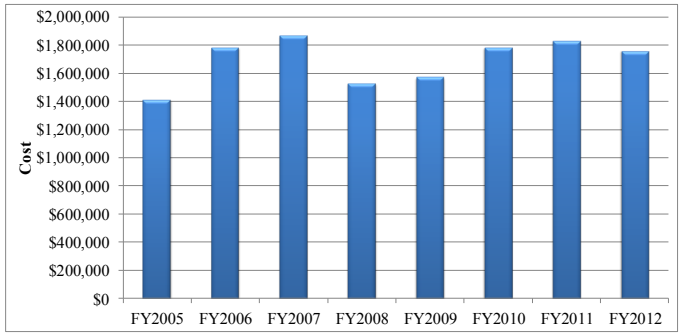


Figure 2 Cost of Litter to UDOT

A few conclusions & recommendations for maintenance and prevention regarding highway litter were provided by the research:

- Utah's "Litter Hurts!" campaign was very effective.
- School based awareness campaigns have proven most effective in modifying individual behavior in a number of causes.
- Picking up litter after the fact also has programs (Adopt-A-Highway).
- UDOT operates a Sponsor-A-Highway program where a contractor sells urban freeway professional litter collection to private sponsors in exchange for advertising.
- County and city prisoner crews and public restitution work crews are used in some areas at no cost to UDOT.
- Littering fines include a maximum of $200 for private parties and $1000 for commercial haulers, if it is the 2nd offense.

For more information, please contact Russ Scovil of the UDOT Research Division, rgscovil@utah.gov.

By: David Stevens, P.E.,
UDOT Research Division

Round Two of SHRP 2 Implementation Assistance Announced

There has been a lot of buzz among state DOTs about TRB's second Strategic Highway Research Program (SHRP 2). Opportunities to implement tools and processes resulting from the research are increasing. According to the AASHTO SHRP 2 website, 13 research products are being rolled out to state DOTs for implementation in 2013, and eight products in 2014.

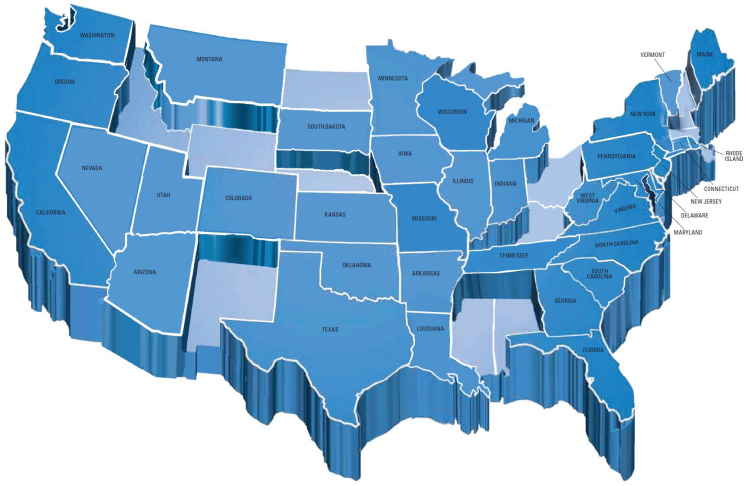
FHWA and AASHTO recently announced that the second round of the SHRP 2 Implementation Assistance Program, involving an application process, will be held in August. This implementation and technical assistance is often linked to state DOT projects. It is available at three participation levels: proof-of-concept pilot, lead-adopter incentive, and user incentive. A series of webinars will be presented in July with detailed information on the second-round products. Following are the four products that will be highlighted in the second round and associated webinar dates:

July 18: Railroad-DOT Mitigation Strategies (R16)
July 23: Expediting Project Delivery (C19)
July 24: Performance Specifications for Rapid Renewal (R07)
July 26: Managing Risk in Rapid Renewal Projects (R09)

Registration for the free webinars and more information on the second round of implementation assistance are available via the FHWA and AASHTO SHRP 2 websites. Recorded versions of these webinars will also be available online. UDOT Divisions interested in applying for SHRP 2 implementation assistance should coordinate with their Group Leader or Region Director.

Earlier this year six products were highlighted in the first round of the SHRP 2 Implementation Assistance Program. UDOT was selected to receive a lead adopter incentive to implement the product known as L01/06 - Organizing for Reliability Tools. This SHRP 2 product is intended to improve travel-time reliability through innovative operations and management.

Recently SHRP 2 released an update map highlighting 37 states that are participating in 119 SHRP 2 activities. Utah is now shown on the map as a participant, based partly on UDOT's involvement in beta testing of a guide for more effectively involving private sector freight stakeholders in the planning and development process for highway capacity projects (project C15).



SHRP 2 participating states, TRB, June 2013

Through its SHRP2 Tuesdays webinar series, TRB provides information on SHRP 2 research and resources that FHWA and AASHTO are making available to implement the research products. Free registration for upcoming webinars and access to recorded webinars are available at the TRB SHRP 2 website. Following are three upcoming webinars in this series:

July 30: Integrating Priorities of Utility Companies and Transportation Agencies (R15B)
August 6: Establishing Monitoring Programs for Mobility and Travel Time Reliability (L02)
August 20: Managing Risk in Rapid Renewal Contracts (R09)

We look forward to successful implementation of key SHRP 2 products within UDOT.

By: Grant Schultz, Ph.D.,
Brigham Young University
Kevin Nichol, P.E., MPA,
UDOT Research Division

Evaluating the Safety Effects of Signal Improvements

In a recent report entitled "Evaluating the Safety Effects of Signal Improvements," researchers from Brigham Young University used a hierarchical Bayesian model to analyze the safety effectiveness of new and modified traffic signal installations. Multiple analyses were performed to identify the effects on overall crashes, severe and non-severe crashes, and for different subsets of the data based on speed at the intersection, functional class of the roadway, and crash type. Crash modification factors (CMFs) were developed for multiple scenarios for both new and modified traffic signals. The resulting CMFs for new signal installations and signal modifications for non-severe and severe crashes are shown in Table 1.

Table 1 Summary of CMFs for Signal Improvements

	Non-Severe (1-3)		Severe (4-5)	
	New Signal CMF	Modified Signal CMF	New Signal CMF	Modified Signal CMF
All Signals	1.42	1.19	0.56	0.54
LT Angle	1.63	1.61	0.52	1.02
Head-On	0.42	0.21	0.64	0.42
Rear-End	2.18	1.32	1.35	0.67
Sideswipe	1.23	1.38	0.64	1.03
High Speed	1.52	1.33	0.50	0.56
Low Speed	1.16	1.11	0.94	0.70
Minor Arterial	1.14	1.00	0.62	0.51
Other	1.71	1.26	0.58	0.67

The results showed that there was an increase in overall crashes for both new signal installations and modifications to existing signals. The severe crash analysis revealed that there was an increase in non-severe crashes and a reduction in severe crashes; the improvements are effectively reducing severe crashes and improving safety at intersections. A benefit-to-cost (B/C) analysis was also performed for each improvement to determine how long it would take to recover the cost of installation. The B/C analyses indicate that there is a safety benefit to both improvements and that new signal installation costs can be recovered in approximately 5 years while the installation of a left-turn signal modification can be recovered in approximately 9 weeks. Both values are based on safety benefits only and do not include operational impacts.

The data collection process for this study revealed a need for improved data collection for signal improvement projects in the future. To aid UDOT in future data collection, a one-page data collection form was created with all information needed to run the analyses. The data collection form is illustrated in Figure 1. It is anticipated that as this form is utilized within UDOT, more detailed analyses can be conducted in the future to better understand causation of any increases in crashes as a result of signal installations.

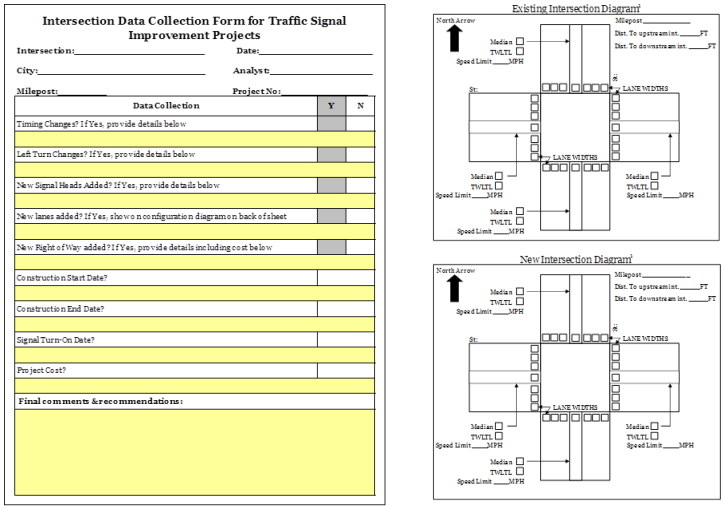


Figure 1: Front & Back of Form

For more information, contact Prof. Grant Schultz of BYU at gschultz@byu.edu; or Kevin Nichol in the UDOT Research Division at knichol@utah.gov.

By: Kyle Rollins, P.E., Ph.D.,
Brigham Young University
Darin Sjoblom, P.E.,
UDOT Geotechnical Division

Passive Force-Deflection Relationships for Skewed Bridge Abutments

Passive force-deflection behavior for densely compacted approach fills must be considered in bridge design to ensure adequate resistance to both seismic and thermally induced forces. Current design codes do not distinguish between skewed and non-skewed bridge abutment geometries. However, in the 2010 Chilean earthquake skewed bridges collapsed at twice the rate of non-skewed bridges as shown in Fig. 1. The shear resistance preventing sliding is also directly related to the passive force.

Fig. 1. Collapse of skewed bridge and survival of adjacent non-skewed bridge in the 2010 Chilean Earthquake (Unjohn, 2010).

To understand the behavior of skewed abutments better, the pooled fund study no. TPF-5(264) was initiated by UDOT, Brigham Young University (BYU), and other interested states in 2012. A series of large-scale lab and field tests were performed with abutment skew angles of 0, 15, and 30 degrees. To simulate an abutment, field tests involved a pile cap 11-ft wide by 15-ft long by 5.5-ft high with and without densely compacted sand backfill. As shown in Fig. 2, in one set of tests the backfill was confined by Mechanically Stabilized Earth (MSE) wingwalls running parallel to the sides of the abutment. In other tests, wingwalls were perpendicular to the sides of the abutment as shown in Fig. 3. The backfill consisted of sand and was placed to a depth of 5.5 ft. The test setup made it possible to apply loads of up to 1.2 million pounds and to deflect the "abutment" nearly 4 inches.

Fig. 2. Large-scale field tests simulating abutment backwall with 30 degree skew and MSE wingwalls confining the backfill soil

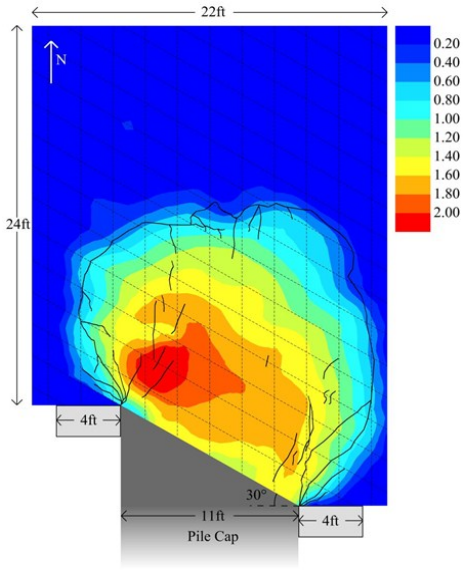


Fig. 3. Color contours of backfill heave (inches) for test with 30° skew with cracks where failure surface intercepted the ground surface.

As shown in Fig. 3, the vertical heave of the backfill soil was concentrated near the corner of the acute side and amounted to nearly 4% of the fill height. The failure surface also skewed outward towards the acute side. The failure surface typically daylighted at a distance behind the wall suggesting a log-spiral failure surface.

Typical passive-force vs. deflection curves for a suite of tests at different skew angles are shown in Fig. 4. Despite the variations in geometries, all these field and lab tests have consistently shown a significant reduction in passive force with an increase in skew angle. For example, at a skew angle of only 30° the passive force typically decreases by about 50%. As passive force

By: Kyle Rollins, P.E., Ph.D.,
Brigham Young University
Darin Sjoblom, P.E.,
UDOT Geotechnical Division

Passive Force-Deflection Relationships for Skewed Bridge Abutments Cont.

decreases, the resistance to deflection and sliding along the abutment also decreases which increases the potential for poor bridge performance.

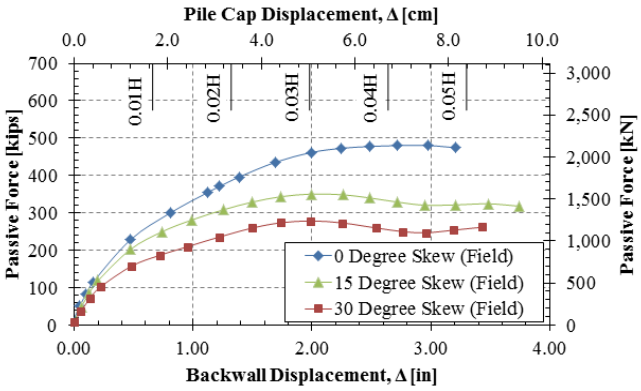


Fig. 4. Passive force-deflection curves for tests on abutment with skew angles of 0°, 15° and 30°.

The soil stiffness appears to be largely unaffected by skew angle for small displacements until the ultimate resistance is approached. The maximum passive force was achieved at a deflection between 3 to 5% of the backwall height, H, but this deflection also seems to decrease somewhat as skew angle increases. The sliding friction, which is equal to the passive force multiplied by the tangent of the soil-abutment interface friction angle, typically required about 0.25 inch of lateral movement to fully develop.

To account for the decreased passive force as a function of skew angle the simple equation

$$P_{p(skew)} = R_{skew}\, P_{p(no\text{-}skew)}$$

was developed where $P_{p(skew)}$ is the ultimate passive force for a skewed abutment and $P_{p(no\text{-}skew)}$ is the ultimate passive force with no skew. The reduction factor R_{skew} was back-calculated from the results of the field and laboratory tests conducted to this point as shown in Fig. 5. Considering the variation in wingwall geometry, backfill height and wall width to height ratios for the various tests, back-calculated R_{skew} values show very good agreement with the proposed R_{skew} equation in Figure 5 based on early lab tests.

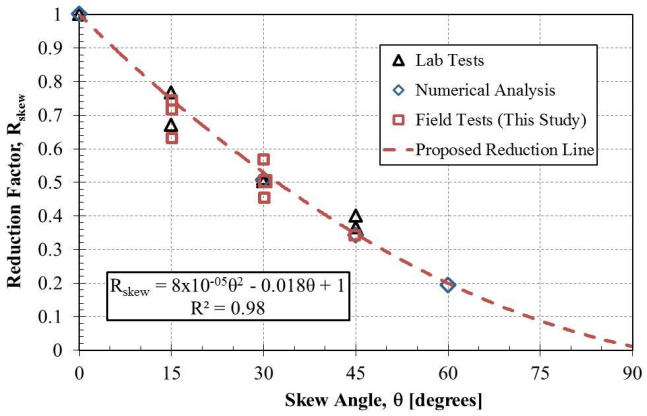


Fig. 5. Reduction factor, R_{skew}, to account for reduced passive force as a function of abutment skew angle.

This simple equation should make it possible to implement the results of the research into future bridge design projects and new design codes. Prof. Rollins of BYU recently presented the results of the research to two technical committees at the 2013 AASHTO Subcommittee on Bridges and Structures Annual Meeting in Portland, Oregon. UDOT bridge and geotechnical engineers, Technical Advisory Committee members, and Prof. Rollins are working with these committees to have the results incorporated into future AASHTO codes.

This study is being funded through a pooled-fund mechanism with contributions from FHWA and state DOTs from California, Montana, Minnesota, New York, Oregon, and Utah. Utah serves as the lead agency with Darin Sjoblom as UDOT champion and David Stevens as project manager. An additional nine tests are being carried out this year to investigate skew angles of 45 degrees, the effect of different soil types, Geosynthetic Reinforced Soil (GRS) backfills, and reinforced concrete wingwalls.

For more information, see the pooled fund web page for study no. TPF-5(264) or contact Prof. Kyle Rollins of BYU at rollinsk@byu.edu; Darin Sjoblom in the UDOT Geotechnical Division at dsjoblom@utah.gov; or David Stevens in the UDOT Research Division at davidstevens@utah.gov.

Research Calendar of Events/Updates

FY2013 UDOT EFFICIENCIES REPORT INFORMATION

The time for collecting information on successful UDOT initiatives for the FY2013 Efficiencies Report is just around the corner. This is the annual effort where the UDOT Research Division collects write-ups from Groups and Regions, verifies details and compiles the Efficiencies Report for UDOT's Executive Director. UDOT Senior Leaders will then highlight the information in this report in front of the State Legislature. Typically, the official information request and template are sent out in August or September. We look forward to seeing the "game changing" initiatives that showed significant cost savings for UDOT in FY2013 and appreciate UDOT leaders' participation in the reporting process. Past years' reports can be viewed at www.udot.utah.gov/go/efficiencies.

RESEARCH FUNDING OPPORTUNITIES (click to see the full document)

SEPTEMBER 1, 2013 - NCHRP Highway IDEA Proposals **DUE**

SEPTEMBER 1, 2013 - ACRP Synthesis of Practice Topics **DUE**

SEPTEMBER 16, 2013 - NCHRP FY 2015 Problem Statements **DUE**

SEPTEMBER 16, 2013 - Safety IDEA Proposals **DUE**

WEBINARS (For more information, contact Joni DeMille at jdemille@utah.gov)

Title	Day/Date	Time
NHI Innovations: FRP Composite Bridge Decking (NHI)	Tuesday, July 23	12:30 PM – 2:00 PM
Fuel Usage Factors in Highway and Bridge Construction (TRB)	Wednesday, July 24	12:00 PM – 1:30 PM
NHI Real Solutions: Embedded Data Collector for Driven Pile Foundations (NHI)	Thursday, July 25	11:00 AM – 1:00 PM
Roundabout Signing and Marking: State Perspectives & Case Studies (TRB)	Monday, July 29	12:00 PM – 1:30 PM
Airport Emergency Management and Irregular Operations (IROPS) [TRB]	Monday, August 19	12:00 PM – 1:30 PM
How to Design a Superior Meeting Experience	View at your convenience, on demand (1-hr duration)	
Trust at Work: Four Keys to Building Better Work Relationships		